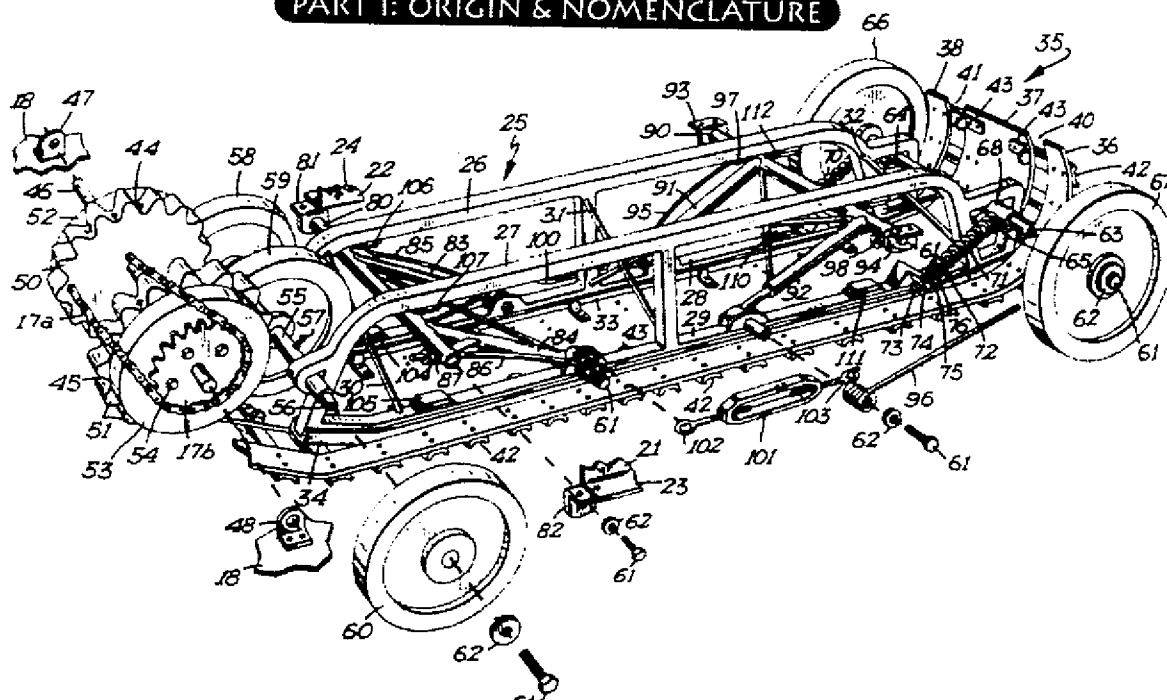


EXHIBIT A

TRACK SUSPENSIONS TODAY

THE ADJUSTABLES

PART I: ORIGIN & NOMENCLATURE



The single most characteristic component of a snowmobile, the track suspension, aka: *skidframe*, is surprisingly complex and quite simple at the same time. Today's designs are very similar one to the next but, as always, there are the details.

In Part I, we discover where this unique system came from and what elements go together to enable its essential functions.

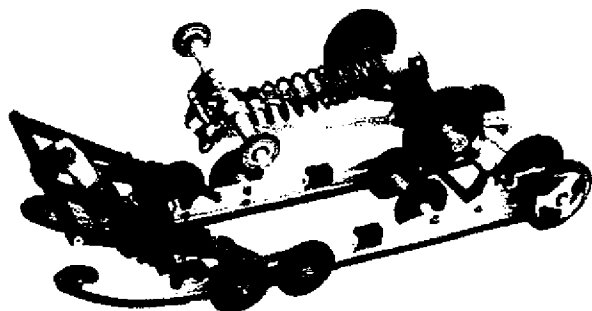
Instead of the sporty snow-going vehicles we know and love today, the snowmobile might've turned out to be much more like a little tank - a clumsy and plodding vehicle capable of snow travel but not much fun. What happened to prevent this fate was the emergence and development of a key suspension component for the flotation track that permitted an amazing amount of balance, traction and control - essential qualities in a recreational vehicle.

Just over 25 years ago, back when snowmobiles rode and handled much more like the aforementioned tanks than the lithe snow skimmers we ride now, the rows of little suspension wheels under the tunnel copied from tank designs were abandoned in favor of a suspended platform for the snow-

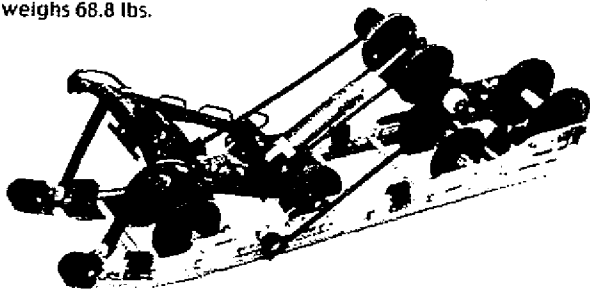
mobile track that offered far greater flexibility and performance. Known today as the *skidframe*, the sliding surface platform built for the track to run on transformed the experience profoundly and the transformation continues to this day.

ABOVE DRAWING: When the first skidframe patents were filed in the early 1960s, no one could've imagined where this technology would lead. As the years have gone by, the skidframe has developed more and more capability but, as this patent drawing of the pioneering skidframe used in the first Arctic Cat Panthers illustrates, today's modern versions don't have to use as many parts to get there.

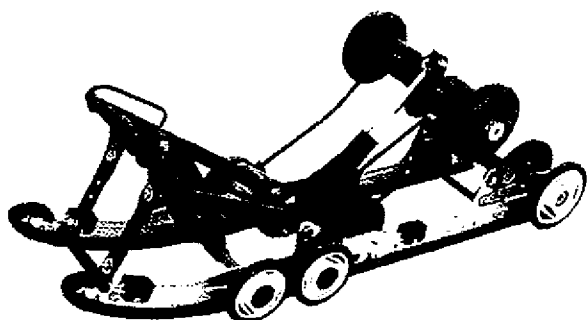
STORY & PHOTOS BY C J RAMSTAD



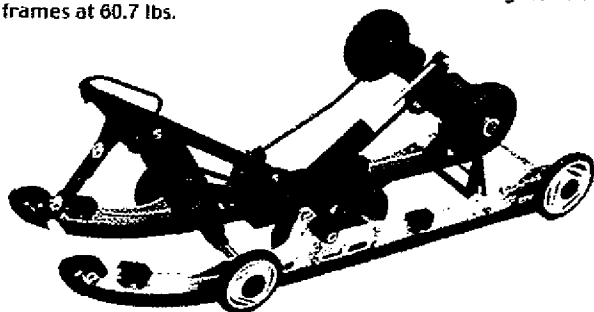
YAMAHA PRO ACTION PLUS used in 2003 Yamahas including the new RX-1 features the only 3-point chassis mount in current use. Fitted with a coupler called the Full-Range Adjuster and a shock angle adjustment, the same basic layout is model specific with shock and spring calibration, the Viper version weighs 68.8 lbs.



FASTRACK FIRECAT used only in two Firecat models in 2003 is a narrowed version of what Arctic Cat has built for many years with the addition of a front-rear coupler and the deletion of the familiar torque link mount on the rear arm. This smaller frame is AC's lightest trail frame at 57.6 lbs.



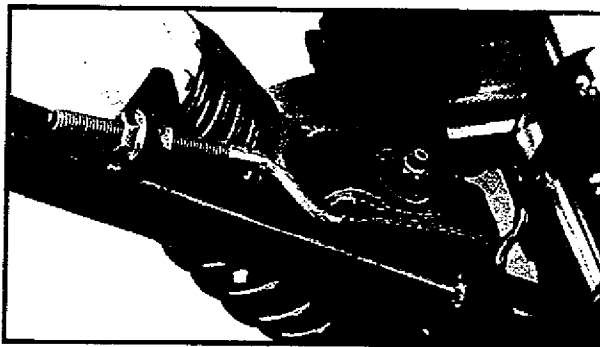
SC-10 used in most performance Ski-Doo models in 2003 features a variety of calibrations based on model and package, largely spring and shock choices. A scissors-stop type coupler is used and the rear arm shock angle can be altered to tune shock piston acceleration rates. One of the lighter trail frames at 60.7 lbs.



SC-10 "Aircooled" appears in several Ski-Doo air-cooled models. This skidframe, used in various forms since the middle 90s, is aimed at simplicity and lightweight operation with primarily preload and limit strap adjustment available. This is the lightest skidframe built by Ski-Doo and the lightest trail skid in this review at 56 lbs even.

In 1975, when the first skidframe in a direct line to what we use today appeared it displayed two trailing arms as signature components. The front trailing arm of course, was conceived as the forward connecting point for the moving platform and the rear arm was to be the connecting point for the rear of the platform.

But something more startling and pivotal happened when this concept was put to the test in the dynamic world of snowmobiling. The



One of the earliest suspension adjustments, the limit strap control front arm movement and determines the amount of vehicle weight carried on the skis. This bolt adjust is used on Yamaha's Pro Action Plus.

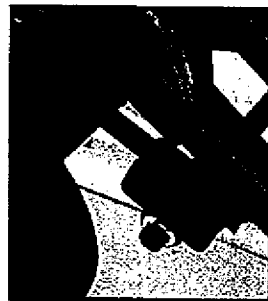
torque effect of engine power working through the track created a throttle sensitive weight shift factor on the front trailing arm that gave the snowmobile something it never had before: Balance.

It wasn't long before there were several variations on this theme from the many makers of the time and, before the 80s could begin, the skidframe concept had completely taken over in the sport. There were several reasons for this rise to dominance including better suspension function (i.e. more travel), lighter weight, reduced complexity and longer life. But it was the original "torque arm" effect that remained the most compelling - the ability of the twin trailing arm skidframe to provide the dynamic weight shift balance point necessary to make a snowmobile agile.

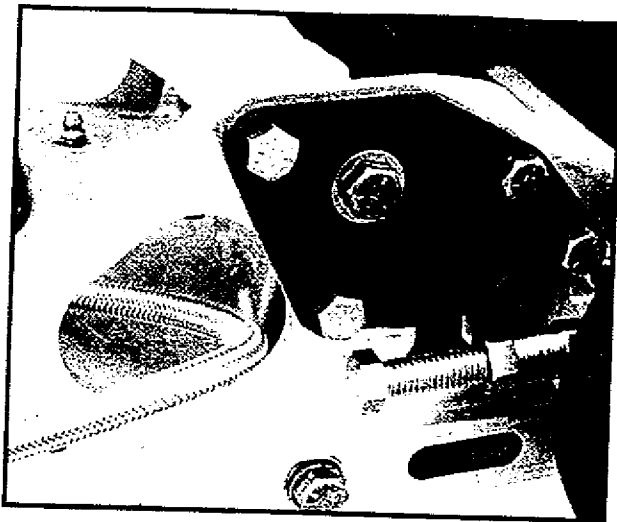
Looking at the current skidframes reviewed on these pages, it's easy to spot the several commonalities all these designs share in 2003.

All accomplish their core function utilizing two trailing arms fastened at one or another place between the tunnel and the suspension rail that provide the contact pressure where the track meets the snow. All feature a combination shock and spring assembly to control the action of each of these arms and all feature one or another combination of wheels to modify the track pressure on the rail and guide the track on its oblong path around the inside of the tunnel.

Other commonalities include the use of high-molecular polyethylene (hi-fax) as an anti-friction medium where the track contacts on the rail and a maximum movement detent on the front arm called the limit strap made of rubber or metal. Some system of setting the load value on the torsion or coil springs is also found on all these skids



The time-honored cam-style spring adjustment for ride height found on all skidframes since the 1970s. Some makers use cams on collover shocks to achieve the same adjustment effect.



Introduced in the early 90s, the coupler links the action of the front and rear arms to allow more accurate calibration and more travel control. This is the original design seen on the M-10 in 1993.

Add up these common elements and the sum is basically the skidframe as we knew it during the 80s and most of the 90s. A rider had the adjustabilities of spring preload (ride height) and limit strap length (ski pressure) to adjust and that was about it.

During that nearly two decades, one design puzzle remained unsolved. The front and rear arms continued to operate more or less

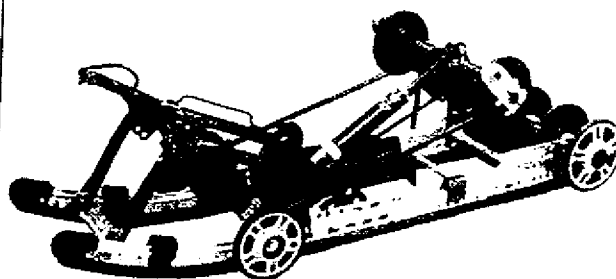
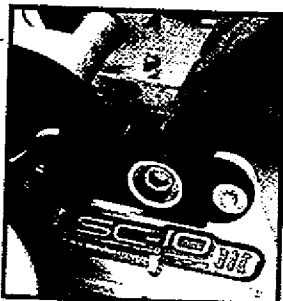
independently of each other from the first designs forward. The free moving front arm was deemed necessary to preserve the all-important weight shift and balance function, but this free movement came with a cost in terms of ride quality. Snowmobile engineers constantly struggled with trying to balance spring and shock values in a system where sometimes one or the other arm would be engaged, sometimes both.

The situation was exacerbated by the trend toward

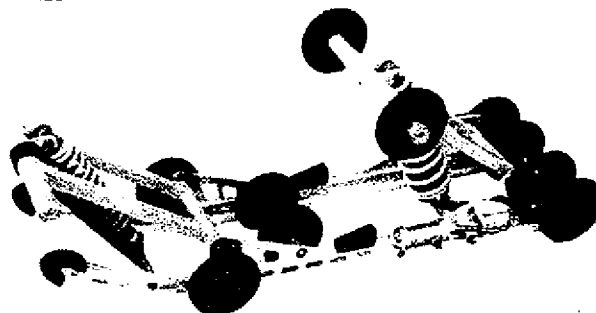
This design has taken many forms over the years as each maker has applied their own theory to the idea. This is the latest version used by Yamaha on the RX-1.

increasing travel that dominated the 90s but a solution appeared in 1993 that has since become a ubiquitous element in snowmobile skidframe design. The aftermarket M-10 skidframe introduced a system to connect the function of the two arms - called a coupler - and this concept has since has a benchmark for the prototypic skidframe and nearly all sus-

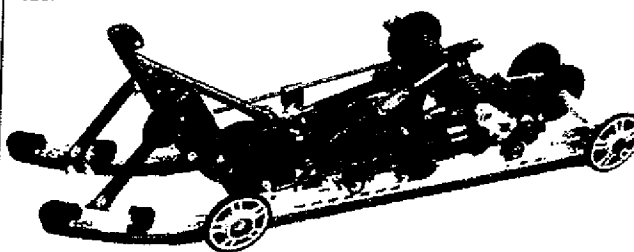
The other major coupler design utilizes movement stops on the rear arm scissors. The moment of coupling is controlled by adjustable cams on the scissors or the stops.



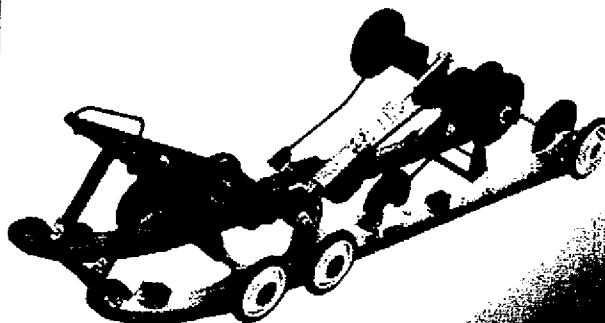
FASTRACK 2R AC's most familiar and respected suspension has seen many detail changes to arm lengths, mounting points and coupler design and this season features an adjustable 2-way rear coupler for the first time. Also used with varying shock detail and wheel counts in the ZL series where it weighs 60.6 lbs.



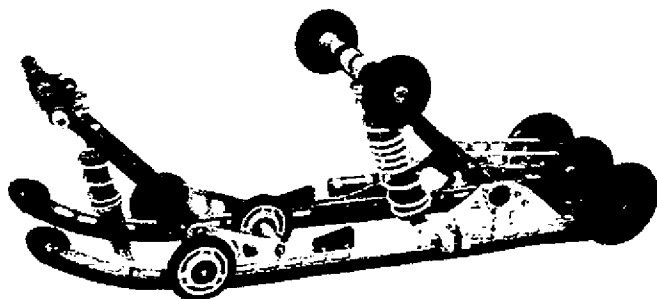
M-10 designed by FAST, Inc. in the early 90s introduced the coupler concept along with the shock angle adjuster and a true 10+ inches of vertical travel. Used in all Blades and in several Polaris models, the M-10 has both critics and devotees but no one denies its pioneer status and light weight at 57.8 lbs.



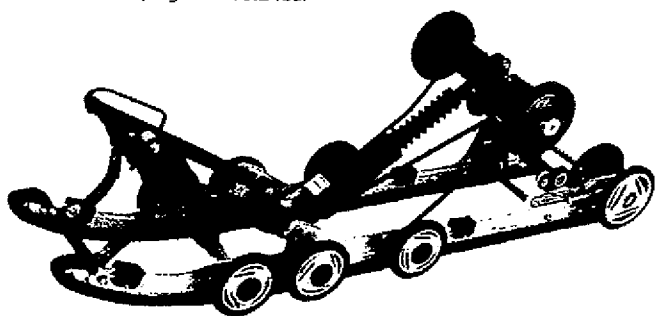
FASTRACK 2-UP used on a variety of AC two passenger models since its introduction in 1993, is essentially a trail FastTrack with the addition of a fiberglass overload spring which can be flipped into action for the added weight of two riders. The added mechanism makes the 2-Up weigh 68.5 lbs.



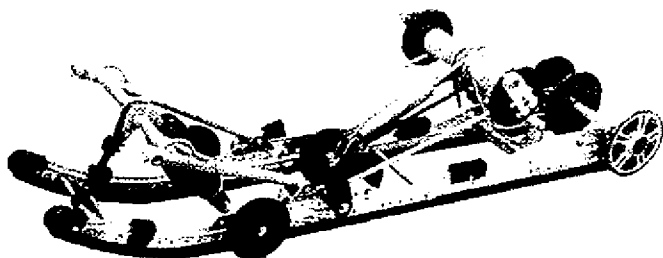
SUMMIT 144 is the skid used in Ski-Doo models based on SC-10 geometry but, like most skids in use in 2003, sans the coupler mechanism. Known for controlled weight the Summit weighs in at 62.7 lbs.



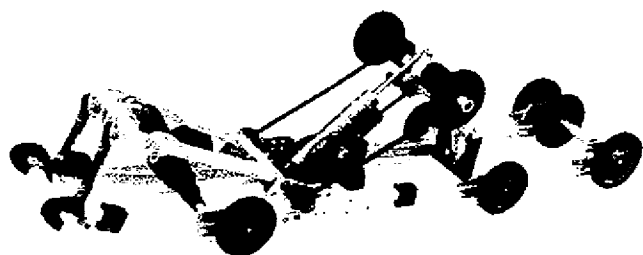
TAG is the newest skidframe from Blade introduced for 2003 with a unique "live axle" design that manages track tension for the suspension's 16 inches of travel. The coupler moves up to the top of the rear arm mount in this design and the axle link provides a track tension G-bump control while remaining relatively light at 58.2 lbs.



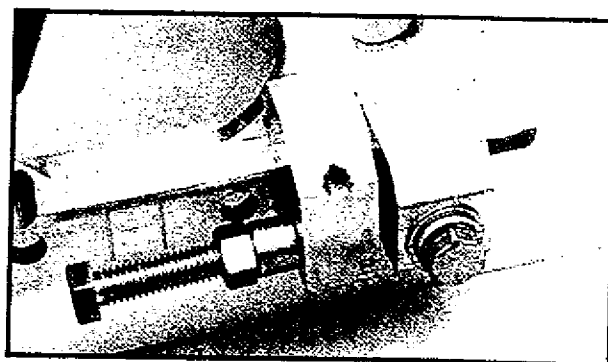
SC-10 II "Airshock" is used in select Ski-Doo Touring models in 2003 to introduce automatic load leveling to snowmobiling. Sensing the weight of the passenger load, the airshock maintains ride height to deliver consistent ride quality for one or two riders. Tips the scales at 70.9 lbs.



FASTRACK MOUNTAIN recently revised for use on the M1 mountain series from Arctic Cat, the mountain version maintains some coupling effect while it substitutes some materials to keep the skid as light as possible while revised mountings emphasize flotation. The lightest mountain skid in this review at 56 lbs even.



RMK 144 used in Polaris mountain models appears with no coupler like most mountain skids and features a relatively large reservoir Ryde FX rear shock. An evolutionary design known for good flotation and durability, the RMK skidframe weighs 58.4 lbs.



The angle of the shock in relation to the skidframe's movement determines the acceleration rate and speed of the shock piston. This characteristic is altered by the FRA adjustment on the M-10.

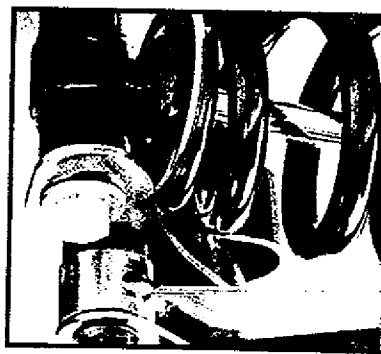
pensions pictured here display this feature in one form or another. The coupler allows the front arm torque effect to continue (mostly) unaffected while it links the two trailing arms for dealing with the ride and comfort issues.

With the all but universal adoption of the coupler another adjustment was added, that of the coupling moment. This is the point in the suspension travel where the trailing arms cease being independent and are linked together. The exact point where this occurs is a setting available at the coupler location in the varying designs used today.

Of all off-road vehicles, the snowmobile presents the greatest challenge to suspension designers for two main reasons. The first comes from the enormous range of conditions presented by the winter environment. Trails can vary from smooth and slippery to chewed-out and filled with craters and moguls. In-between there are stutter bumps, rollers and drifts to attack rider comfort and control. The second reason is - of all off-road vehicles, the snowmobile is the only one that operates without tires. The lack of the pneumatic buffer provided by a tire makes the job of suspending a snowmobile truly monumental.

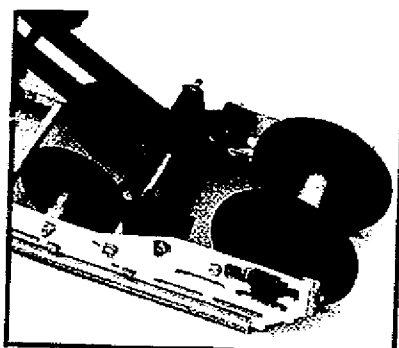
Adjustments to suspension are rarely if ever discussed by users of 4WD trucks, ATVs and dirt bikes, but adjustability is the first line of defense in snowmobiling and a myriad of detail adjustments have found their way into the sport to satisfy this need.

Not an adjustment, the torque link system for mounting the rear arm traps torque that would otherwise affect track tension on several Arctic Cat Fastrack skids and more recently on the Polaris EDGE and Pro X models.



The shock function can be adjusted with a selection of shock mounting tabs. This method is used by Ski-Doo on the SC-10 II and on Yamaha's Pro Action Plus suspension.

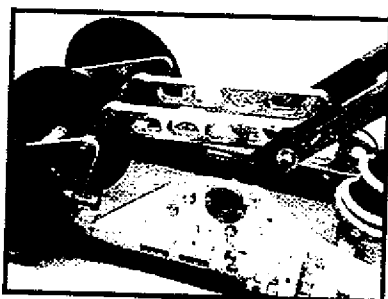




Weight is always a consideration and especially with the part is an "unsprung" moving suspension. Arctic Cat and Polaris have recently moved in the direction of narrower skids to shave mass in their high-performance models. This is the rear of the 13.5 inch Firecat skidframe.

Skidframes on most touring and performance snowmobiles for the most part all display adjustability to shock and spring values equal in sophistication to any other form of motorsport. Riders today can tune their ride and handling with adjustments - depending on make and model - to shock compression and rebound damping, shock absorber lever ratio, trailing arm attachment points.

There are also several automatic and from-the-saddle adjustments available that permit the suspension to be tuned on the fly or to tune itself in response to varying trail conditions using hydraulics or electronics.

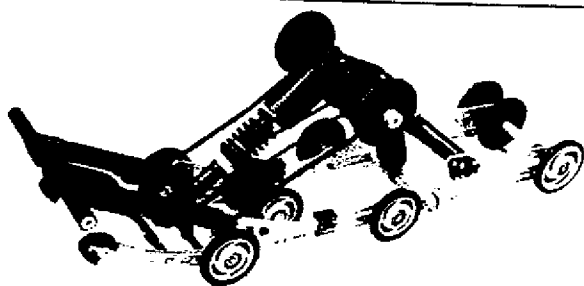


As travel numbers increase, challenges appear in terms of track tension. Blade pulls off 16 inches of travel in the new HPO TAG skidframe by applying a link to the rear "live axle" that preserves accurate track movement throughout its travel.

Accompanying this story are pictures and descriptions of all the distinct skidframes being produced for 2003. Despite the many basic similarities, there is tremendous variation

in detail design and in the way each suspension is tuned and adjusted. These are the assemblies that define the snowmobile as we know it. Knowing and understanding how and why this component works is an important key to better, more enjoyable snowmobiling. ▲

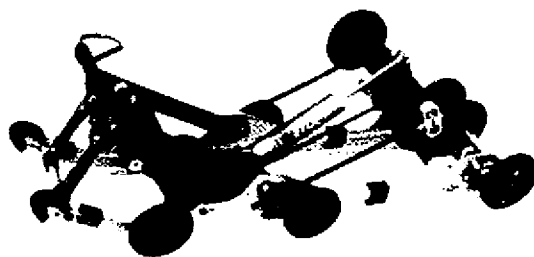
In the next issue of SUPERTRAX, look for Part II of The Adjustables for more about those detail adjustabilities, how to use them and - this is crucial - evaluate the results.



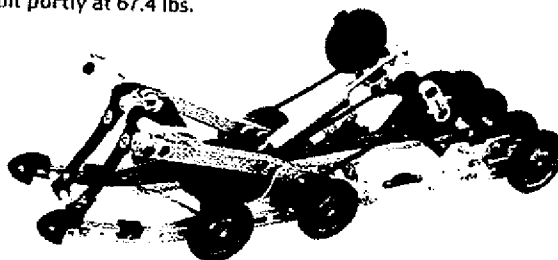
EDGE TOURING is the latest design from Polaris using essentially an Extra-12 type front arm design mated to an M-10 rear arm design. This suspension is aimed at delivering premium touring ride with the minimum of rider adjustment and comes in as Polaris heaviest for 2003 at 72.8 lbs.

NEXT IN PART II SKIDFRAME FUTURE

The snowmobile track suspension is highly evolved but development continues at the same frantic pace as ever. Be here next issue to see where the art and science of snowmobile ride & handling is headed ... and why.



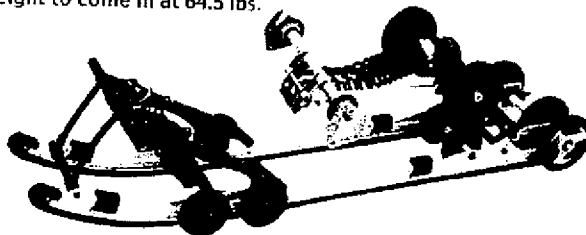
EDGE suspension is the mainstream design of Polaris five different suspensions offered for 2003. Featuring dual adjustable coupling and a torque link style rear arm mount plus Fox shocks in several applications, this popular skidframe scales a bit portly at 67.4 lbs.



PRO X is a refinement of the coupled EDGE design that widens out the front arm lever, alters several detail geometries and uses the torque link rear arm mount. Usually fitted with reservoir shocks - some models have shock bodies from offroad legend Walker Evans - the Pro X trims down to 63.9 lbs.



M-10 ACE appears in some limited edition Polaris models and is sold for aftermarket installation by FAST, Inc. Essentially an M-10 with a very durable geared shock angle adjuster for on-the-fly suspension adjust from the saddle, the ACE makes the most of the sophisticated tuning on the M-10 while shaving off weight to come in at 64.5 lbs.



PRO ACTION PLUS MOUNTAIN used in Yamaha mountain models including the new RX-1 maintains a full coupling effect with Yamaha's sliding rod Full Rate Adjuster and features an altered (longer) front arm and revised mount aimed at maximum flotation. The heaviest mountain skid at 74 lbs even in the RX-1.



GETTING THE IQ TO MARKET



(left) Clay models are a visual tool. As designs are finalized, the models can be sculpted to view possible concepts.

(right) CAD software speeds up the development process and tests designs prior to prototype assembly.

An event in November 2001 changed the spirit of the IQ development. The World Snowmobile Association (WSA) Duluth National

season-opening smocross in Duluth, Minnesota, was the first time the public saw Ski-Doo's radical new machine. Its new racer was in the REV chassis.

"We were working on the project long enough to know the REV had a lot of the same things we were working on," Sampson said. We were disappointed when the REV was there ahead of us.

Sampson and the other engineers probably underestimated the impact of the REV chassis. With it, Ski-Doo stole Polaris' 12 years of market leadership and their pride of being No. 1 with it.

Pat Bourgeois, Polaris' marketing communications manager, said Polaris' 900 Liberty engine concept was pitched shortly after CEO and President Tom Tiller took over in 1998. The laydown engine design and how it would fit in a chassis were part of that plan, Bourgeois said.

Though Polaris might have pleased its consumers and dealers if it released the IQ chassis sooner, the Polaris engineers we spoke with were unified when they said they didn't want to release the new product until it was ready and until it met all the required checkpoints of the Polaris Development Process (PDP). The PDP is the quality control measure Polaris uses on everything it builds prior to going to market.

"PDP forces the company to have a long development cycle," Pat Adrian, snow project leader, said. "The really big thing on the IQ was that in the past we've always just taken the chassis we've had and updated a system. [The IQ] was a new chassis, new suspensions and a new engine. We'd never done all three at the same time. When you throw something that big into action, there are a lot of questions to have answered before you get the go-ahead."

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